ALUMINUM PHOSPHIDE
PROCEDURES FOR FUMIGATION

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Ontario

Ministry
of the
Environment

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(1) GENERAL CHARACTERISTICS

Aluminum phosphide* plus ammonium carbamate in the presence of moisture releases hydrogen phosphide gas, also known as phosphine (PH_3). The initial decomposition of the pellet/tablet involves the ammonium carbamate component, releasing ammonia (warning gas) and CO_2. This component serves to reduce heat generation in the reaction of phosphide with water. The pellets/tablets are impregnated with paraffin to provide a timed delay of this hydrolysis, thus providing a built-in safety factor for the handling and application of the fumigant.

Detia gas Ex-B is the trade name for a dust formulation containing 57% aluminum phosphide and 43% inert ingredient.

(2) CHEMICAL AND PHYSICAL PROPERTIES OF PHOSPHINE

Chemical Formula	PH_3
Boiling Point	-126°F. (-87°C.)
Freezing Point	-208°F. (-133°C.)
Specific Gravity	1.214 (air=1)
Molecular Weight	34.04
Vapour Pressure at 70°F and Standard Atmospheric Pressure	10.5 cu ft/lb.
Odour	Pronounced carbide or garlic-like odour
Solubility in Water	26 ml/100 ml @ 62°F. (17°C.) (very slightly soluble)
Threshold Limit Value	0.3 ppm (ACGIH - 1975)

(3) FORMULATIONS

There are three formulations of aluminum phosphide on the market in Canada. Phostoxin is available in two forms:

Tablet:	Diameter 0.8"x0.2" wide Height 3g producing approximately 1g PH_3
Pellet:	Diameter 0.37" Height 0.6g producing approximately 0.2g PH_3

Detia gas Ex-B is available in a single form:

Dust:	57% dust formulation in paper sachets (bags) containing 34g each.

*Phostoxin is the trade name for a tablet or pelleted formulation containing:

Aluminum Phosphide	55%
Ammonium Carbamate	41%
Edible Paraffin	4%

PHOSPHINE AS A FUMIGANT

Phosphine gas has excellent penetration characteristics (30 to 50 feet in flat or silo grain storage). The high velocity and vapour pressure of the PH_3 molecule permits deep penetration of even the most densely packed commodities.

The same molecular velocity that permits deep penetration also produces highly desirable aeration characteristics. With normal ventilation procedures, PH_3 concentrations will be removed from both the product and the fumigated stack within 60 minutes.

Phosphine has demonstrated its effectiveness on many species of insects, rodents and other pests. It kills insects in all stages of their life cycles: egg, larva, pupa and adult.

Phosphine gas is explosive under vacuum conditions. Therefore, its use is restricted to atmospheric fumigation with or without a tarpaulin or cover. Cloth or canvas tarpaulins are not suitable for fumigation purposes. Polyethylene, or vinyl-coated films or tarpaulins are satisfactory when properly sealed to the floor or base surface to prevent gas leakage.

In order to use aluminum phosphide in a grain fumigation, the applicant must be licenced. Aluminum phosphide is registered in Canada for the following uses:

USE	RATE OF APPLICATION
STORED GRAIN (BARLEY, CORN, MILLET, OATS, RICE, SORGHUM, WHEAT) eggs, larvae and pupae of: Angoumois grain moth, flat grain beetle, grain moths, granary weevil, Indian meal moth, Khapra beetle, lesser grain borer, Mediterranean flour moth, merchant grain beetle, red flour beetle, rice weevil, sawtoothed grain beetle, cadelle, dried fruit moth	RES 99.33 g (from pellets) per 1000 bu. Apply only in vertical storage with turning factilities. Aerate head space after completion of time of exposure. RES 54.67 g (from pellets) per 1000 cu ft. Apply in box cars or to sacked grain under gas-impermeable tarpaulins. No special ventilation is needed in box cars 5 days after fumigation. Remove tarps from stored grain at the end of fumigation. Maintain through ventilation around the stacks. RES 297 g (from tablets) per 1000 cu ft. Inject into the grain with a probe, or feed into the grain stream as it is flowing into a bin. Even distribution throughout the grain is essential. Times of exposure required are approximately as follows: At grain temperatures of 4°C. to 12°C., allow 10 days; at 12°C. to 15°C., allow 5 days; at 16°C. to 20°C., allow 4 days; above 20°C., allow 3 days.

PROCESSED FEEDS AND FOODS eggs, larvae and pupae of: Angoumois grain moth, cadelle, dried fruit moth, flat grain beetle, grain moth, granary weevil, Indian meal moth, Khapra beetle, lesser grain borer, Mediterranean flour moth, merchant grain beetle, red flour beetle, rice weevil, sawtoothed grain beetle	RES 54.67 (from pellets) per 1000 cu ft. RES 74.25 (from tablets) per 1000 cu ft. Apply in a tight atmospheric fumigation chamber, a box car, or under a gas-impermeable tarpaulin. Under no conditions shall any processed food come in contact with any aluminum phosphide or with aluminum phosphide-residues. Aerate processed food for two hours after completion of fumigation. Times of exposure required are approximately as follows: At commodity temperatures of 12°C. to 15°C., allow 5 days; at 16°C. to 20°C., allow 4 days; above 20°C., allow 3 days.
TOBACCO cigarette beetle, tobacco moth	RES 33 g (from tablets or pellets) per 1000 cu ft. Times of exposure required are approximately as follows: At 12°C. to 15°C., allow 5 days; at 16°C., to 20°C., allow 4 days; above 20°C., allow 3 days. Aeration time on hogshead should not be less than 3 days; on other types of storage, 48 hours.
BAGGED/PACKAGED TREATED SEED FOR PLANTING (CEREAL, GRASS, SORGHUM, SMALL LEGUME SEED) Angoumois grain moth, bean weevil, cadelle, cigarette beetle, confused flour beetle, dried fruit moth, granary weevil, Indian meal moth, Khapra beetle, lesser grain borer, red flour beetle, rice weevil, rusty grain beetle, Mediterranean flour moth, sawtoothed grain beetle, tobacco moth, yellow mealworm.	RES 58.14 - 116.28g (from 57% dust formulation in paper sachets) per 1000 cu ft. #DU. In box cars, bulk rail cars, trailer vans, shipping containers: tape sachets to rigid perforated cardboard with spacing between the sachets. Tape across the ends of the sachets only. Place or fix the cardboard, sachet side up, inside the box car, van, or shipping containers. In bulk rail cars, place the cardboard, bag side up, on the flanges of the hatch openings. This may require cutting the cardboard to size. In warehouses, vaults: Place sachets on floor in a systematic manner. Use total floor space available. Close, seal, and post warning signs on doors or hatch covers. Minimum exposure requirements under ideal conditions are as follows: below 10°C, do not fumigate; 10°C - 15°C fumigate at least 168 hours; 15°C - 25°C fumigate at least 96 hours; above 25°C fumigate at least 72 hours. Aerate products at least 48 hours before offering to the consumer. For rusty grain beetle, fumigate at least 96 hours at 27°C. Gas concentration must be above 100 ppm at the end of the 4th day.

A phosphide concentration of 300 ppm, 48 hours after application, or 200 ppm, 60 hours after application will ensure control of all common stored products insect species. A minimum of 72 hours exposure is essential.

Phosphine fumigation offers no residual protection against subsequent infestation. Therefore, good sanitation practices, standard warehouse insect control procedures and adequate segregation of highly infestable suspect commodities (such as dog food) are necessary to maintain insect control and limit re-infestation potential.

ADVERSE EFFECT ON MISCELLANEOUS MATERIALS

Under specific atmospheric conditions involving moisture condensation on the item being fumigated, phosphine will corrode copper or products containing copper. For this reason, when such items are to be fumigated special care must be taken to ensure that they are not placed in an area, or covered in a manner, that may induce condensation.

In accordance with label instructions, aluminum phosphide must not be used in such a manner to allow the pellets/tablets or unreacted residues (ash) to come in contact with any processed food.

With the exception of the above, phosphine gas is chemically inert and will not combine to produce a residue in food.

STORAGE AND HANDLING

(a) Aluminum phosphide tablets are packed in aluminum tubes with tight plastic stoppers which are overpacked in strong, gas-tight tins (90 tablets per tin). Pellets are packaged in a gas-tight aluminum flask (1660 pellets per flask). These containers should be stored in a dry, reasonably cool, ventilated and locked location. As long as the packing remains intact, the shelf life is practically unlimited.

(b) The amount of fumigant necessary for a given application should be calculated ahead of time, so that an appropriate number of containers will be opened.

(c) Containers should be opened in a ventilated area and surgical or thin rubber gloves should be worn when handling the tablets or pellets. Generally, the entire contents of the tablet container should be used in one operation and the empty container should be buried. Wash hands thoroughly, and dispose of gloves after use.

(d) When the use of less than a flask of pellets is necessary, it should be closed tightly and stored again in a dry, cool, ventilated area. Do not refrigerate as condensation may occur once the flask has been opened.

DISPOSAL

Mixing with water will inactivate any unreacted product. Empty primary containers (tubes or flasks) should be buried under 18 inches of soil away from water.

TOXICOLOGY

Hydrogen phosphide is highly toxic to all forms of animal life. Poisoning may be either by inhalation or dermal contact.

Phosphine is not a chronic poison and no evidence has been found to indicate irreversible damage in individuals surviving phosphine poisoning. Extended low level exposure (less than 2.5 ppm of phosphine in air) does not increase susceptibility or produce sensitization to higher concentrations.

The threshold limit value suggested by the American Conference of Governmental Hygenists is 0.3 ppm in air by volume. The threshold limit value refers to airborne concentrations of phosphine to which a worker may repeatedly be exposed for eight hours, day after day without adverse effects.

SYMPTOMS

According to the amount of hydrogen phosphide inhaled, symptoms such as fatigue, pressing sensation in the chest, nausea and diarrhea, may occur immediately or within a few hours. Very high concentrations rapidly result in difficulty in breathing, agitation, unconsciousness and in death.

FIRST AID

Remove the victim immediately into the open air. If ingested, give a teaspoonful of salt in a glass of warm water to induce vomiting. Repeat until vomit fluid is clear. Do not give any antidote. In particular, do not give any substance composed of fats and oils (such as castor oil, butter or milk). Treat the victim as for shock: place in a recumbent position and keep quiet and warm. Apply oxygen breathing equipment, if available, and call for medical assistance.

GAS MASKS AND SELF-CONTAINED BREATHING APPARATUS

An approved gas mask or an approved self-contained breathing apparatus should always be worn whenever there is any possibility of exposure to phosphine. Gas masks or self-contained breathing apparatus should be approved by the United States Bureau of Mines and/or the National Institute for Occupational Safety and Health (NIOSH) for use in a phosphine atmosphere. There are two gas masks and cannisters approved by the Bureau of Mines for phosphine protection up to 0.5% by volume in the area: Mine Safety Appliance Co., Cannister No. 77713 GMC-SS-1 and Scott's No. 600-204-60.

Before entering an atmosphere containing phosphine, be sure to check the mask for leaks. To do this, put on the mask with the cannister attached. Place a hand over the hole in the bottom of the cannister and inhale. If perfectly tight, the face mask will collapse. Cannister gas masks are only air purifying devices; therefore, it is essential that they are used in atmospheres which contain sufficient oxygen to support life (more than 16% at sea level) and which contain generally no more than 2% concentration of phosphine by volume. If the specific exposure concentrations are suspected of exceeding the above limitation, only a self-contained breathing apparatus should be used.

The operational life of a cannister can vary from several minutes to an hour, depending on the design and/or the concentration to which it has been exposed. Once the cannister becomes saturated with phosphine, it no longer protects the wearer.

Unless the maximum time that a cannister should be used in a phosphine fumigation can be pre-determined, a cannister once used, should be broken and discarded for there is no sure way of determining the residual protection remaining in that cannister.

DETECTION OF PHOSPHINE GAS

Use recommended gas detector pumps and tube units to monitor the atmosphere both around and under the fumigation. Gas detector pumps and tube units should be approved by the United States Bureau of Mines and/or the National Institute for Occupational Safety and Health (NIOSH) for the detection of phosphine gas. When monitoring phosphine concentrations, replicate readings should be taken. If you require any help in choosing detector equipment, you should contact the Pesticides Control Personnel, Ontario Ministry of the Environment, in your erea.

GUIDELINES FOR FUMIGATION UNDER TARPAULIN WITH ALUMINUM PHOSPHIDE

Materials

(a) Polyethylene film: thickness 1.5 ml (0.0015 inches), 30 feet wide or thickness 2 ml (0.002 inches), 40 feet wide and a roll of sufficient length to be economically practical.

(b) Sand snakes: made of 10 ml (0.01 inches) polyethylene tubing 5 inches in width, cut in 6-foot lengths and filled with sand. (an equivalent substitute may be used to seal tarps to the floor or ground surface).

(c) Aluminum phosphide pellets or tablets.

(d) Bulk pellet measuring device: a container which will hold a predetermined number of aluminum phosphide pellets will greatly facilitate pellet counting. A styrofoam coffee cup which is cut down to a volume of approximately six fluid ounces will hold 200 to 250 pellets.

(e) Masking tape

  (1) Four-inch wide, 4 ml plastic tape is recommended for patching holes and tears in the polyethylene film (tarpaulin).

  (2) Two to four-inch wide masking tape is recommended for patching and sealing sash around windows and doors.

(f) Measuring tape: 50-foot wide.

(g) Knife: for cutting polyethylene tubing and sheets.

(h) Thermometer: Scale should be sufficient to determine commodity temperature.

(i) Gas masks and cannisters.

(j) Aluminum pans or suitable substitute: These are used to contain the aluminum phosphide pellets or tablets while the fumigant is in use. The pans may be prefabricated or made at the site through the use of aluminum foil. The number of pans used should be sufficient to hold all of the pellets or tablets in a single layer - no pellet should be on top of another. A large stack of infested commodities will require several one square-foot pans.

(k) Gas extraction bulb or gas sampling pump: A device for pulling fumigant atmosphere through gas concentration detection tubes.

(l) Detector tube: Gas concentration detection tube for determining concentrations in post-lethal doses, concentrations for safe working conditions, and concentrations which are sub-lethal to target insects.

(m) Paddle: For use in stirring residue in disposal water.

(n) Bucket: A container for use in disposing of pellet or tablet residue.

(o) Detergent and water: Used in disposing of pellet and tablet residue, both of which may contain about 1% toxic material. Detergent is necessary to emulsify the paraffin coating which was on the pellets and tablets and is now part of the residue.

(p) Signs: Warning signs 14" x 10" stating "Danger" in red letters 2¼ inches high on a white background and details of the extermination should be placed at each entrance.

(q) Gloves: Used in handling pellets. Surgical gloves serve very well for this purpose.

PREPARATION

(1) Each exterminator should be carrying an approved breathing apparatus.

(2) Arrange infested commodity for convenience of tarping. In-place fumigation can be conducted without moving commodity. Adherence to directions precludes necessity to isolate from normal work areas.

(3) Measure dimensions of stack to determine polyethylene film requirements.

(4) Cover commodity stack with polyethylene film allowing a minimum of 18 inches floor lap on all four sides.

(5) Seal polyethylene to floor by positioning sand snakes or suitable substitute over floor lap. Overlap sand snakes at least 6 inches to assure a tight seal. Fold corners carefully to avoid "bunching" of the polyethylene film and seal with additional sand snakes at each corner.

(6) Check tarp for tears and/or holes and close with 4 ml plastic tape.

(7) Stabilize corner folds and reinforce tarp over sharp-edged packaging with 4 ml plastic tape.

(8) Prepare aluminum pans, or equivalent, in which to place aluminum phosphide.

(9) Do not fumigate with tablets or pellets when the temperature is below 41°F. (5°C).

(10) Do not fumigate with dust when the temperature of the product is below 50°F. (10°C).

PROCEDURES

(a) Measure the length, width, and height of the tarped commodity stack to establish the gross cube.

(b) Calculate the fumigant dosage at the rate of 100 pellets (20 tablets) per 100 cubic feet. Use label dosage recommendations for outside fumigation (165 pellets/33 tablets per 1000 cubic feet).

(c) It is not necessary for an operator to wear a gas mask while handling aluminum phosphide pellets or tablets which are being poured from their original container and placed immediately inside the polyethylene envelope covering the commodity. Phosphine gas is evolved slowly enough by normal atmospheric moisture to preclude the use of gas masks under these circumstances. Protective gloves are necessary while handling aluminum phosphide at any time. Aluminum phosphide containers must remain closed at all times except when actually pouring the contents from the container.

(d) Place measured number of aluminum phosphide pellets or tablets into aluminum trays or pans. Do not crowd the pellets and make sure all pellets are spread in a single layer in the tray.

(e) Lift tarp and slide the fumigant trays on the floor under the polyethylene and reseal the tarp to the floor with sand snakes or equivalent.

  (1) The aluminum phosphide pellets or tablets should be placed under the tarp within 15 minutes from exposure to air.

  (2) A pungent ammonia odour will be noted on initial exposure and decomposition of aluminum phosphide tablets or pellets: at the concentrations produced, this gas is non toxic.

  (3) Some carbide odour may be evident when the aluminum phosphide container is first opened.

  (4) The tray with aluminum phosphide can be positioned under the tarp at any convenient location since the penetration characteristics of this fumigant will equalize concentration levels throughout the load regardless of pack type and tray locations.

  (5) Phosphine gas will be liberated with disintegration of the pellet/tablet (15 to 30 minutes after exposure) and will be evidenced by a penetrating carbide odour. Garlic odour will not be readily noticeable if aluminum phosphide has been placed under the tarp within the 15-minute period described above.

(f) Read and record commodity temperatures at time of aluminum phosphide tablet or pellet introduction.

EFFECTIVENESS

(a) A record of fumigation data should be maintained for each application.

(b) Determine the phosphine concentration within the polyethylene envelope at the end of 24 hours after aluminum phosphide introduction, by extracting 100 cc of fumigant atmosphere through the gas detection tube by means of the gas extraction bulb, or pump. Gas may be withdrawn by puncturing directly through the polyethylene tarp or by using a prepared sampling site.

(c) The chemical contents of the tube will change colour upon contact with phosphine and the concentration can be read directly from the graduated markings.

(d) Determine and record minimum commodity temperatures during the fumigation period.

(e) Gas concentration readings should be checked and recorded during the fumigation period (particularly at 48 and 72 hours after introduction of the aluminum phosphide pellets) to determine maintenance of gas concentration levels.

(f) In areas of very low humidity (less than 40% relative humidity), it may be necessary to add a pan of water or wet the floor adjacent to the fumigant tray in order to provide sufficient moisture for decomposition. Do not allow direct contact between water and the fumigant.

(g) To be effective, the stack must remain under fumigation for a minimum of 72 hours at ambient temperatures of 68°F. (20°C.) or above. The tarp may then be lifted to allow ventilation and dissipation of remaining gas concentration or (preferably) tarp may be left in place for an additional 24 to 48 hours. At temperatures below 68°F. (20°C.), follow label instructions regarding exposure time.

(h) Check and record the phosphine concentration within the polyethylene envelope at the end of the exposure period.

COMPLETION

(a) Open one end of stack by lifting or tearing polyethylene film. If gas concentration is greater than 50 ppm, (TLV for 10 minutes), wearing of a gas mask is advisable.

(b) Normally, under most warehouse conditions, personnel can remove the sand snake seal, lift the polyethylene sheet, and vacate the area without using gas masks. The proper safety precautions and techniques to be used are part of the training in the use for this fumigant. Do not attempt this operation without proper instruction.

(c) Ventilate and vacate the area for 60 minutes after lifting the tarp. Do not attempt to remove the tarp from the stack until after the ventilation is complete.

(d) Allow commodity and warehouse to aerate after removing tarp before permitting warehouse personnel to re-enter the fumigated area.

(e) If desired, gas concentration readings may be taken after thorough ventilation following fumigation. Continuous exposure to 0.3 ppm (TLV - 0.3 ppm) or less can be tolerated with no ill effects.

(f) Collect the pellet trays and emulsify the ash residue by mixing with liquid detergent in a bucket of water. The emulsion should be buried under 18 inches of soil away from water.

GUIDELINES FOR IN-TRANSIT FUMIGATION WITH PHOSPHINE

(1) The purpose of in-transit fumigation (I.T.F.) is to preclude susceptible commodity infestation during shipment and to minimize the mechanical transfer of indigenous railcar insect populations into the food storage facilities.

(2) The procedures described herein may be applied to both static and rolling stock, at time of receipt and/or shipment.

(a) Railcars exhibiting noticeable infestation at the time of receipt may be fumigated prior to loading:

(i) If a car is fully loaded and is in good state of repair, effective fumigation can be accomplished by introducing aluminum phosphide pellets or tablets and sealing doors with tape.

(ii) If a car is partially loaded and/or in a questionable state of repair, more effective fumigation can be accomplished by covering the entire car with a 2ml polyethylene film. When covering the entire railcar, include the space between the car and the ground in determining cube and calculating dosage.

(b) For in-transit fumigation, all holes and/or open cracks in the floor, walls, or roof should be repaired or otherwise sealed before normal coopering. In addition the floor of both loosely constructed cars and of brand new cars will require an additional floor covering of a minimum of 4 ml polyethylene sheeting in 12-feet widths, positioned to provide approximately a one-foot lap up the sides and end of the car.

(c) The fumigant should be applied in accordance with the manufacturer's label instructions, except that the recommended dosage rate is as follows:

(i) Pellets 150-165/1000 cubic feet

(ii) Tablets 40-45/1000 cubic feet

(d) Refer to General Guidelines for handling and application procedures.

(e) Under no condition should the formulation containing aluminum phosphide be used so that its unreacted residues come in contact with any processed foods. For in-transit fumigation procedures, pellets or tablets should be placed in moisture-permeable envelopes stapled to the car wall adjacent to the side door.

(f) Make a final check to clear all personnel from the vehicle. call out loudly that a gas is being released to be sure that all is clear.

(g) Following application/distribution of the fumigant within the car, doors should be carefully sealed with a minimum of 4 inches wide, double-ply masking tape. A polyethylene or tar paper strip may be necessary to completely seal the lower track of each door. Accordingly, one door may be sealed as above, prior to loading the car.

(h) Approved warning signs (14 inches x 10 inches) stating "Danger" in red letters 2½ inches high on a white background indicating car loading is under fumigation with aluminum phosphide should be firmly attached to each side door in such a position as to be readily visible and legible. Warning signs should be annotated with date and hour of fumigation, in addition to proper aeration and residue disposal instructions.

3. RECEIVING CARS UNDER IN-TRANSIT FUMIGATION

(a) At time of receipt, fumigation warning signs should be checked to determine exposure time. Cars received in less than 72 hours from introduction of the fumigant should not be entered without wearing an approved gas mask.

(b) Cars arriving with more than 72 hour fumigation exposure time can be safely aerated by opening one or both doors for 30 to 60 minues prior to unloading.

(c) Fumigant residues should be disposed of by burial after emulsification in water with a liquid detergent.

4. RESTRICTIONS

(a) Fumigation temperature limitations listed on the manufacturer's label will be guided by commodity temperature, not environmental temperature.

(b) In-transit fumigation procedures should not be employed if commodity temperature is less than 41°F. (5°C.) in conjunction with a transit time of less than 72 hours.

GUIDELINES FOR FUMIGATION OF VERTICAL SILO BINS WITH ALUMINUM PHOSPHIDE

MATERIALS

(a) Polyethylene film, thickness 1.5 ml (0.0015 inches) sufficiently wide to cover top of bin.

(b) Aluminum phosphide tablets or pellets.

(c) Automatic pellet dispenser.

(d) Thermometer: Scale should be sufficient to determine commodity temperatures.

(e) Gas masks and cannisters.

(f) Gas extraction bulb or gas sampling pump: A device for pulling fumigant atmosphere through gas concentration detection tubes.

(g) Detector tube: Gas concentration detection tube for determining concentrations in post-lethal doses, concentrations for safe working conditions, and concentrations which are sub-lethal to target insects.

(h) Signs: Warning signs 14" x 10" stating "Danger" in red letters 2½ inches high on a white background and details of the extermination should be placed at each entrance.

(i) Gloves: Used in handling pellets. Surgical gloves serve very well for this purpose.

(1) PREPARATION

Brick, concrete or steel silo bins with turning facilities that are closed on all sides and sufficiently gas-tight are suitable for an aluminum phosphide fumigation.

The following should be known prior to the first fumigation:

(a) Capacity of bins to be fumigated.

(b) Average filling capacity per hour or total time required for filling each bin.

(c) Voltage and kind of current (alternating or three-phase current, two-pole or three-pole connection) required when using the pellet dispenser.

Before each fumigation, the following should be ascertained:

(a) Average commodity temperatures.

(b) Humidity of commodity.

(c) Type of pests.

The required number of pellets are then placed into the hopper (see label and page #2). The main switch operating the dispenser is turned on at the control panel. The pellets are only released as long as grain is passing along the conveyor belt. In this way, piling of pellets can be avoided. On completion of the day's work, a rubber stopper may be put in the outlet and the remaining pellets left overnight, but for longer periods, the pellets must be removed and the dust brushed out. (No water or other liquids should be used).

Pellets or tablets may also be thrown through the manhole or a feed-tube into the stream of commodity, while it is being moved to the bin or they may be dropped onto the commodity on the conveyor belt.

The pellets or tablets should be handled according to the procedures on page #4 and gas masks should be worn whenever there is any possibility of exposure to phosphine. Always work in pairs. Signs should be placed at entrances. If open-topped bins have a large cross-section and are already filled, they can be treated by injecting tablets into the grain with a probe and covering the bin with polyethylene. Even distribution throughout the grain is essential.

(2) EXPOSURE TIMES

Times of exposure required are approximately as follows: at grain temperatures of 12°C. to 15°C., allow 5 days; at 16°C. to 20°C., allow 4 days; above 20°C., allow 3 days. Do not fumigate if commodity temperature is less than 5°C. or 41°F.

(3) AERATION

Hydrogen phosphide is a highly volatile gas and slowly diffuses through brick or concrete walls. This occurs unnoticeably and may take from 8 to 10 days.

RECORDS

The effectiveness of a given fumigation can be determined by monitoring gas concentrations periodically during fumigation, and plotting results. Replicated results indicate that minimum gas concentrations of 200 ppm 24 hours after application; 300 ppm 48 hours after application; and 200 ppm 72 hours after application will give reasonable assurance of complete control of all species commonly encountered. The following is a suggested record format:

ALUMINUM PHOSPHIDE FUMIGATION RECORD

1. Supervisor: ______________________ 2. Date: ____________

3. Facility: ____________

4. Fumigation team: ______ (Names) ______________________

5. Description of site: Indoor: ____ Outdoor: ____ Hard Stand ____ Ground: ____

6. Commodity: ______________________

7. Volume of Commodity Stack Fumigated: ______________________

8. Dosage Applied (number of pellets/tablets): ______________________

9. Safety Requirements:

(a) Local authorities notified: Time Phone No.

(1) Medical

(2) Security

(3) Fire

(b) Warning signs posted: Buildings ________ Commodity Stack ________

(c) Proper gas masks available: Yes _____ No _____

(d) Building atmosphere monitored following ventilation: Yes ____ No ____

(e) Manner of pellets/tablets residue disposal: ______________________

10. Effectiveness:

(a) Temperature: High ________ Low ________ Relative Humidity ________

(b) Gas concentration at: 24 hours: ______________________

48 hours: ______________________

72 hours: ______________________

(c) Pellets marked with date fumigated: Yes _____ No _____

11. Remarks: ______________________

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